

Western Ecological Research Center

Publication Brief for Resource Managers

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Quantifying Landscape Ruggedness for Habitat Analysis

Terrain ruggedness is often an important variable in habitat models for wildlife such as desert bighorn sheep, which occupy mountain ranges in the American Southwest. One of the most important determinants of sheep habitat within these ranges is the presence of escape terrain, cliffs or steep, rocky slopes where sheep can outdistance or outmaneuver predators. Most methods used to quantify ruggedness are indices derived from measures of slope, and these indices may not clearly distinguish steep, even terrain from steep terrain that is uneven and broken. USGS scientist Dr. Kathleen Longshore and coauthors from the University of Nevada, Las Vegas, have developed a tool for biologists that provides a quantitative measure of terrain that can be used for habitat analyses where topography affects the distribution of vegetation or wildlife. Their study is published in the *Journal of Wildlife Management*.

Using a geographic information system, the scientists developed a vector ruggedness measure (VRM) of terrain based on a geomorphological method for measuring vector dispersion that quantifies local variation in terrain more independently of slope than other methods tested. They examined the relationship of VRM to slope and to two commonly used indices of ruggedness (land surface ruggedness index, or LSRI, and terrain ruggedness index, or TRI) in three physiographically different mountain ranges within the Mojave Desert (Eldorado Mountains, Black Mountains, and Eagle Mountains). They then used VRM, slope, distance to water, and springtime bighorn sheep adult female locations to model sheep habitat in the three ranges.

Their results showed that VRM directly measured heterogeneity of terrain more independently of slope than did either TRI or LSRI, and unlike them, VRM differentiated smooth, steep hillsides from irregular

Management Implications:

- The VRM quantifies local variation in terrain more independently of slope than other methods tested, and VRM and slope distinguish two different components of bighorn sheep habitat.
- For bighorn sheep, using VRM in conjunction with measures of slope will provide more quantitative and accurate habitat assessments when determining patch size and configuration of escape terrain.
- Quantitative analysis of terrain ruggedness appears to be important in understanding behavior and distribution of bighorn sheep.

terrain that varied in gradient and aspect. Their results indicated that perception of escape terrain by bighorn adult females appeared to incorporate both ruggedness and slope, but the relative importance of the two variables seemed to shift in response to the availability of steep slopes. During spring, when escape terrain is important for adult females with lambs, adult females consistently selected for rugged terrain in all three mountain ranges. In contrast, the importance of slope in habitat models varied among mountain ranges. In the Black Mountains, which had the greatest availability of steep slopes, slope was the most important factor in habitat selection. Conversely, in the Eldorado Mountains, which had the lowest availability of steep slopes, slope was not a significant factor in habitat selection. Both slope and ruggedness were equally important in the Eagle Mountains, which had a more even distribution of slope values than the other two ranges.

Sappington, J. M., K. M. Longshore, and D. B. Thompson. 2007. Quantifying landscape ruggedness for animal habitat analysis: A Case Study Using Bighorn Sheep in the Mojave Desert. *Journal of Wildlife Management* 71:1419–1426.